



CAPTIVE REARING INITIATIVE FOR SALMON RIVER CHINOOK SALMON

**1999 ANNUAL REPORT
NMFS PERMIT NO. 1010**

Report Period January 1999 to January 2000

Prepared By

**Peter Hassemer, Principal Fisheries Research Biologist
Paul Kline, Principal Fisheries Research Biologist
Jeff Heindel, Fish Culturist**

INTRODUCTION

Idaho Department of Fish and Game's (IDFG) long-term objective for salmon management is to maintain Snake River salmon populations at levels that will provide sustainable harvest (IDFG 1996). Restoring currently depressed chinook salmon *Oncorhynchus tshawytscha* populations to historic levels is a prerequisite to this condition. Artificial propagation of spring and summer chinook salmon in the Salmon River basin, through Lower Snake River Compensation Plan (LSRCP) and Idaho Power Company hatcheries, was initiated to compensate for lost production and productivity caused by the construction and operation of private and federal hydroelectric facilities in the Snake River. The mitigation approach was to trap, spawn, and rear a portion of the historically productive local broodstock to produce a large number of smolts (Bowles 1993). When chinook salmon trapping began in 1981 as part of the LSRCP, it was assumed that enough chinook salmon adults would return for harvest and continued hatchery production needs. It was also assumed that hatchery programs would not negatively affect the productivity or genetic viability of target or other populations and that natural populations would remain self-sustaining even with hydropower dams in place. In reality, productivity (survival rates) of wild Snake River chinook salmon declined abruptly with completion of the federal hydroelectric system by the mid-1970s (Petrosky and Schaller 1994). Survival rates used in the hatchery mitigation program models were substantially overestimated. Hence, hatchery programs have been unable to mitigate for the dams or stem the decline of target populations, and numbers of naturally produced salmon declined at various rates throughout the Snake River Basin. Spring/summer chinook salmon returns have been insufficient to meet artificial and natural smolt and adult production predictions, much less provide a consistent harvestable surplus of adults (Hassemer 1998).

The decline of stock productivity and survival associated with development of the Snake River hydrosystem substantially influenced the decline of Snake River spring/summer chinook salmon stocks (Schaller et al. 1999). A recovery strategy that incorporates natural-river function is most likely to increase smolt to adult return rate and provide for recovery of Snake River anadromous fish populations (Marmorek et al. 1998). Pending changes in the mainstem electric hydrosystem and increased smolt-to-adult survivals, our immediate challenge becomes one of preserving the existing metapopulation structure of Snake River chinook salmon so future recovery actions are possible. The listed Snake River spring/summer chinook salmon evolutionary significant unit (ESU) consists of 38 sub-populations (i.e. breeding units or stocks), 28 of which exist in the Salmon River Drainage (NMFS 1995). Preserving the current stock or metapopulation structure is consistent with the pre-decisional Snake River Salmon Recovery Plan (Schmitt et al. 1997, in review), and also supports the Northwest Power Planning Council's goal of maintaining biological diversity while doubling salmon and steelhead runs (NPPC 1994). Metapopulation structure (or biodiversity) can be maintained by preventing local or demographic extinctions.

The IDFG initiated a captive rearing program for populations at high risk of extinction to maintain metapopulation structure. Captive rearing is a short-term approach to species preservation. The main goal of the captive rearing approach is to avoid demographic and environmental risks of cohort extinction; maintaining the genetic identity of the breeding unit is an important but secondary objective. The strategy of captive rearing is to prevent cohort collapse of the specified target populations by providing captive-reared adult spawners to the natural environment, which in turn, maintain the continuum of generation to generation smolt production. Each generation of smolts, then, provides the opportunity for population maintenance or increase should environmental conditions prove favorable for that cohort.

The captive rearing program was developed primarily as a way to maximize the number of breeding units that could be addressed while minimizing intervention impacts. We collect only enough eyed-eggs or juveniles from the target populations to provide what we feel are adequate spawners, about 20, to ensure that minimum demographic spawner goals are met. (According to members of the Stanley Basin Sockeye Technical Oversight Committee, it is reasonable to assume that 20 fish could encompass 95% of the genetic diversity of the population.) The appropriate number of eyed-eggs or juveniles to collect remains somewhat speculative because of the uncertainty associated with the ability of the captive rearing approach to produce adults with the desired characteristics for release into the wild (Fleming and Gross 1992, 1993; Joyce et al. 1993; Flagg and Mahnken 1995). Eyed-eggs or juveniles would be collected each year from cohorts of low resiliency populations; those expected to return 10 or fewer spawning pair to their respective spawning areas. In order to meet program objectives, we must be able to produce an adequate number of adults with the proper morphological, physiological, and behavioral attributes to successfully spawn and produce viable offspring in their native habitats.

Little scientific information regarding captive culture techniques for Pacific salmonids was available at the inception of this program. Flagg and Mahnken (1995) reviewed the status of captive broodstock technology. Following Flagg and Mahnken's (1995), work the IDFG captive rearing program was initiated to develop the technology for captive culture of chinook salmon and to monitor and evaluate captive-reared fish during both the rearing and post-release/spawning phases. In addition to technology development, the IDFG program also addresses population dynamics and population persistence concerns. These population level concerns are: 1) maintaining a minimum number of spawners in high-risk populations, and 2) maintaining metapopulation structure by preventing local extinctions.

This report documents activities under the captive-rearing program from January 1, 1999, through December 31, 1999. Also, activities completed since the inception of the program are summarized in this report. This work is coordinated with the Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1994) and is identified as project 9700100. Funding was provided through the Bonneville Power Administration.

STUDY AREA

Three streams were selected for the initiation of the captive rearing program: the Lemhi River; the East Fork of the Salmon River; and the West Fork Yankee Fork Salmon River (Figure 1). With the exception of the Lemhi River, streams reside in relatively sterile watersheds draining granitic parent material associated with the Idaho batholith. Water quality is high and water temperatures are ideal for chinook salmon rearing. Habitat quality is relatively pristine with some localized riparian degradation, sedimentation, and impact from grazing, mining, logging, road building, and irrigation diversion.

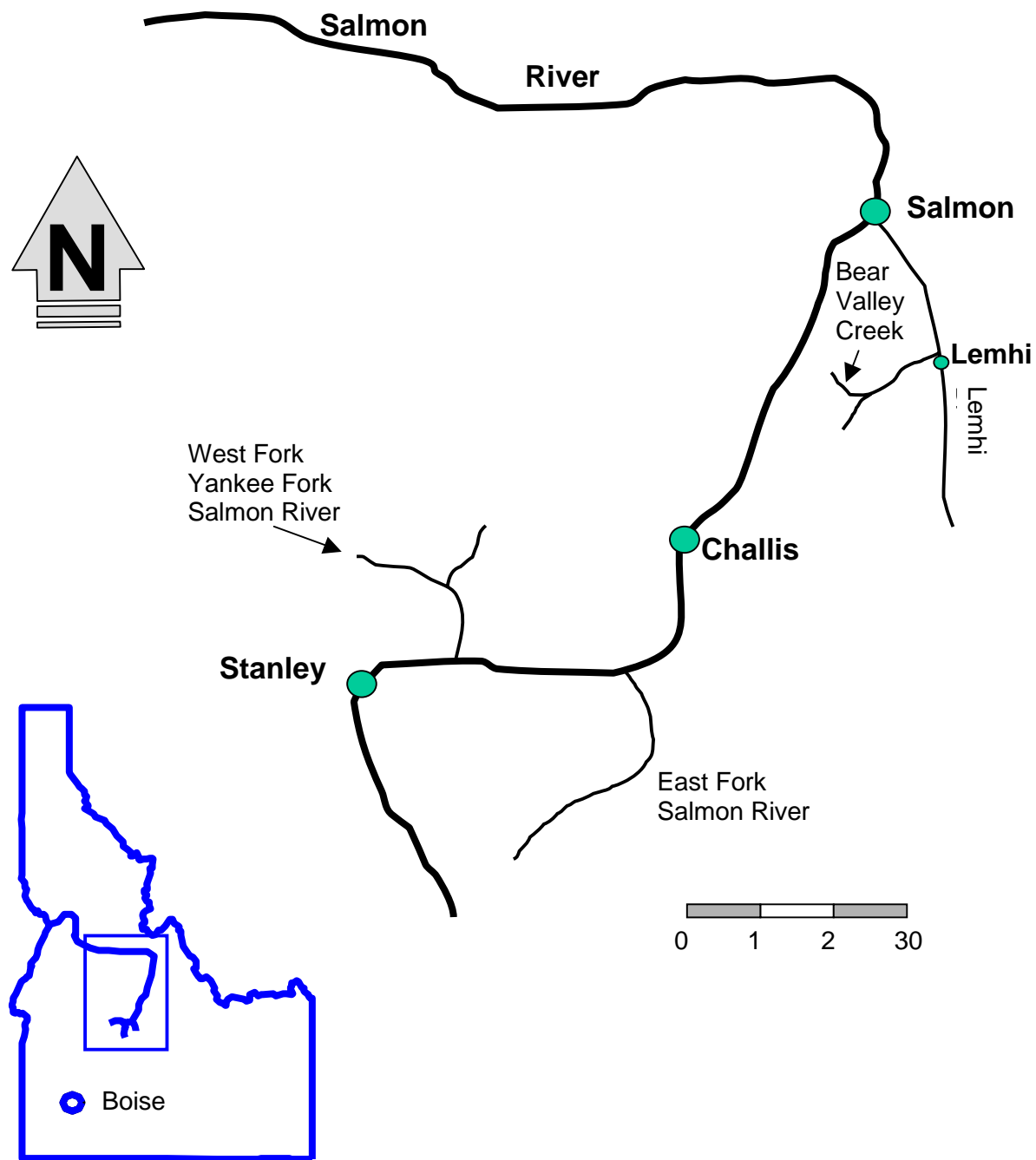


Figure 1. Location of Idaho Department of Fish and Game spring/summer chinook salmon captive rearing program study streams.

The Lemhi River drains productive basaltic parent material resulting in rapid fish growth. The lower river travels through private land developed extensively for agriculture and grazing. Stream habitat typically reflects C channel conditions. Bear Valley Creek, a tributary of Hayden Creek, which flows into the Lemhi River approximately 30 km upstream of its confluence with the Salmon River, was also selected as a captive chinook salmon release site. Bear Valley Creek reflects near pristine B and C channel conditions.

The West Fork Yankee Fork Salmon River drains granitic parent material adjacent to the Frank Church Wilderness. Primarily roadless, the stream has remained non-impacted by land use practices for nearly half a century. Stream habitat typically reflects B and C conditions.

The East Fork Salmon River drains granitic parent material, and is generally less productive than the Lemhi River system. The lower 30 km of the stream runs through ranch and grazing property developed during the last century. The upper reaches of the East Fork Salmon River reflect near pristine conditions with little historical disturbance from logging, mining, or agriculture. Stream habitat typically reflects B and C conditions.

PROGRAM HISTORY

Idaho and Oregon State, tribal, and federal fish managers met during 1993 and 1994 to discuss captive culture research and implementation in the Snake River basin. The outcome of those meetings was agreement that Oregon would initiate a captive broodstock program for selected Grande Ronde River chinook salmon populations, and Idaho would initiate a captive rearing research program for selected Salmon River chinook salmon populations. The primary focus of each of these programs was to evaluate each form of captive culture's effectiveness at meeting population conservation objectives. Implicit within each research project was the objective to develop and test appropriate fish culture protocols, specific to the captive culture of chinook salmon for conservation management of depressed populations.

The Idaho chinook salmon captive rearing program was initiated in 1995 with the collection of brood year 1994 chinook salmon parr from the East Fork Salmon, Lemhi, and West Fork Yankee Fork Salmon rivers. Progeny of brood years 1995 through 1999 naturally spawning chinook salmon were brought into captivity for rearing. Hassemer et al. (1999) summarizes the fish collection and rearing activities of this project from inception through 1998.

METHODS

Captive culture of chinook salmon is a relatively new field and because of this, the role of the Chinook Salmon Captive Propagation Technical Oversight Committee (CSCPTOC) is very important to the success of the program. The CSCPTOC provides a forum of peer review and discussion of all activities and culture protocols associated with this program. This allows for an adaptive management approach to all phases of the program, which supports technological and overall program development, as new information becomes available.

The goal of this project is to develop and test chinook salmon captive rearing, a specific form of captive culture. To achieve this goal, program activities are divided into two functional

bodies: 1) fish culture and 2) field evaluations. Success of the program is dependent on synchronous development of effective rearing technology and the evaluation of post-release adult chinook salmon behavior and spawning success. The methods described here cover both aspects of our evaluations.

Collections for Captive Rearing

Captive rearing groups may be sourced from the wild as eyed-eggs or as juveniles (parr or smolts).

Eyed-eggs are collected using hydraulic sampling methods described by McNeil (1964). To facilitate eyed-egg collections, the location of redds and their corresponding construction dates are accurately recorded. In addition, recording thermographs are located at several sites (near completed redds) to track the accumulation of Celsius temperature units (CTUs). Eggs are hydraulically removed from selected redds following the accumulation of approximately 300 CTUs.

Juvenile chinook salmon are collected using rotary screw traps (E.G. Solutions, Corvallis, OR) and beach seines. Rotary screw traps are passive capture devices generally positioned in the thalweg of the stream. Stream flow turns a baffled cylinder that funnels captured fish to a live well for temporary holding. Idaho Department of Fish and Game and cooperator personnel from the Shoshone-Bannock Tribes attend traps on a daily basis. Captured juveniles may be temporarily held in streamside live boxes until transfer to Sawtooth Fish Hatchery for initial rearing.

Beach seines are used to collect juvenile chinook salmon over a broad range of stream distance. Following the location of juveniles by snorkeling, a beach seine is positioned downstream of the target assemblage of fish. Snorkelers then work cooperatively with seine handlers to capture fish. Fish are temporarily held in streamside live boxes until transfer to Sawtooth Fish Hatchery.

Fish Culture

The IDFG provides daily staffing for the culture of Snake River captive-reared chinook salmon. The fish are reared using standard fish culture practices and approved therapeutants (for an overview of standard methods see Leitritz and Lewis 1976; Piper et al. 1982; Erdahl 1994; Bromage and Roberts 1995; McDaniel et al. 1996; Pennell and Barton 1996). The fish are fed commercial diets produced by BioOregon (Warrenton, OR) or Moore-Clark (Edmonds, WA). Rearing tank size varies with fish age. Rearing densities, diet ration, and tank size are managed to promote optimum growth and for the attainment of program objectives and goals. Individual fish weight is periodically monitored to insure that projected weights track closely with actual weights. Mortalities, both natural and maturation-related, are typically examined by a fish pathologist. Tissues are analyzed for common bacterial and viral pathogens. In addition, tissue samples are removed, frozen (-80°C), and transferred to the University of Idaho or National Marine Fisheries Service (NMFS) for subsequent genetic analysis.

Prior to smoltification, all juvenile chinook salmon are Passive Integrated Transponder (PIT) tagged to facilitate identification and the tracking of specific fish culture information. As an additional measure of stock identification, juvenile chinook salmon receive visible implant

elastomer tags. Tags are color-coded by stock with Lemhi, West Fork Yankee Fork Salmon, and East Fork Salmon rivers receiving red, orange, and green implants, respectively.

Facilities and Protocols

Eagle Fish Hatchery is the primary Idaho site for the culture of captive-reared chinook salmon. Specific pathogen-free artesian water from five wells is currently in use. Artesian flow is augmented through the use of four separate pump/motor systems. Water temperature remains a constant 13.3°C and total dissolved gas averages 100% after degassing. Water chilling capability was added in 1994. Chilled water is used for incubation and for final maturation rearing. Backup and system redundancy is in place for degassing, pumping, and power generation. Nine water level alarms are in use and linked through an emergency service operator. Additional security is provided by limiting public access and by the presence of three on-site residences occupied by IDFG hatchery personnel.

Facility layout at Eagle Fish Hatchery remains flexible to accommodate culture activities. Several fiberglass tank sizes are used to culture chinook salmon from pre-smolt to the adult stage including: 1) 0.6 m diameter semi-square tanks (0.09 m³), 2) 1 m diameter semi-square tanks (0.30 m³), 3) 2 m diameter semi-square tanks (1.42 m³), 4) 3 m diameter circular tanks (6.50 m³), 5) 4 m diameter semi-square tanks (8.89 m³), and 6) 6 m diameter circular tanks (44.5 m³). Flows to all tanks are maintained at no less than 1.5 exchanges per hour. Shade covering (70%) and jump screens are used where appropriate. Tank discharge standpipes are assembled in two sections ("half pipe principal") to prevent tank dewatering when removed for tank cleaning.

Sawtooth Fish Hatchery was completed in 1985 as part of the Lower Snake River Compensation Plan and is located on the Salmon River in the Stanley Basin. Sawtooth Fish Hatchery personnel and facilities have been used continuously since 1995 to hold presmolts prior to their transfer to Eagle Fish Hatchery. Following collection, presmolts are held in 2 m semi-square fiberglass tanks by stream origin. All fish rearing occurs on specific pathogen-free well water. Water temperature varies by time of year from approximately 2.5°C in January and February to 11.1°C in August and September. Back-up and redundancy systems are in place.

Egg and Fish Transfers

Eyed-eggs are transferred from field collection sites to the Eagle Fish Hatchery in perforated shipping tubes. Tubes are wrapped in water-saturated cheesecloth and packed in small, insulated coolers. Ice chips are added to provide proper temperature maintenance. Prior to loading hatchery incubators, eggs are disinfected in 100 ppm iodophore for 30 minutes.

Eggs may be transferred between NMFS and IDFG facilities to meet program objectives. Eyed-eggs are packed as described above and shipped using a commercial air service. Idaho Department of Fish and Game and NMFS personnel are responsible for shuttling coolers to and from air terminals. Eggs may also be transferred to remote field locations for incubation in streamside or instream incubation systems.

Fish are transported to and from collection locations in truck-mounted, insulated tanks (typically 1,136 L capacity) with alarm and back-up oxygen systems on board. For longer duration trips (e.g., from NMFS Washington State facilities to Idaho), larger capacity truck-mounted tanks may be used (3,785 L and 9,463 L capacity). The IDFG obtains the appropriate

permits for interstate transfer of captive chinook salmon to and from NMFS facilities. All vehicles are equipped to provide the appropriate conditions (temperature, oxygen, capacity) to facilitate safe transport of fish to and from specified destinations. In addition, all vehicles are equipped with two-way radios or cellular phones to provide routine or emergency communication capability. Fish are transported by IDFG or cooperator personnel. Prior to releasing transported fish at hatchery or remote release locations, transport and receiving water temperatures are tempered to fall within a 2.0°C range.

Maturation Sorting

Physical maturation sorts are generally initiated in June at the Eagle Fish Hatchery. External signs of maturation including changes in body coloration and the development of maturation-related morphological characteristics are documented. In addition to appearance, maturation in male and female chinook salmon is judged following physical handling events. Fish judged as maturing are isolated, by stock, from general populations. When available, genetic sex information for specific stocks and brood years is incorporated with physical sort data to assist the process of assembling final release groups.

Monitoring Programs

Marking and Release

In 1999, pre-spawn adult releases were made to Bear Valley Creek and to the East Fork Salmon River on 24 August and 25 August, respectively. No adult releases were made to the West Fork Yankee Fork Salmon River in 1999. Transportation and tempering were conducted as described above. Pre-spawn adult releases were conducted according to protocols identified in the original permit application and conservation plan. All fish destined for release to Bear Valley Creek and to the East Fork Salmon River were marked with visible external tags (Petersen disc or Floy) to facilitate fish-specific behavioral observations. In addition, all fish destined for release to the East Fork Salmon River were fitted with radio transmitters to facilitate telemetry investigations. Telemetry equipment was manufactured by Advanced Telemetry Systems. Model R2000 receivers were used in conjunction with three-element Yagi antennas. Type 201, model 10-28 (15 g dry weight) and model 5 (20 g dry weight) transmitters were used. Prior to release, fork lengths, weights, and unique morphological data were recorded and associated with individual PIT tag codes.

Bear Valley Creek—The release site was located approximately 1.6 km upstream of the mouth of Bear Valley Creek. To ensure that fish remained in the release section, a temporary blocking weir was constructed at the downstream end of the evaluation section. A natural barrier was located approximately 2.0 km upstream of the lower blocking weir. Upstream and downstream trap boxes were installed in the lower blocking weir. The trap boxes facilitated the capture and release of wild/natural adult chinook salmon moving upstream into the study area and resident species (primarily bull trout *Salvelinus confluentus* and cutthroat trout *O. clarki lewisii*) moving upstream or downstream of the blocking weir.

East Fork Salmon River—Releases into the East Fork Salmon River were made approximately 31 km upstream of the confluence of the East Fork and mainstem Salmon rivers.

Spawning Behavior Monitoring

On 16 August, a blocking weir was installed at the lower end of the meadow reach in the Bear Valley Creek study area. Upstream and downstream live boxes were constructed within the weir to prevent emigration of study animals and to accommodate the assisted passage of bull trout and wild/natural chinook salmon. A recording thermograph was launched approximately one river mile upstream of the weir location. Within the study section, stream habitat was classified as riffle, run, or pool and each riffle/pool section was uniquely identified and numbered. On the morning of 24 August, maturing fish were loaded into transport trucks, hauled to the study stream, and released into three large pools in the lower meadow reach of Bear Valley Creek. Daily behavioral monitoring was initiated immediately after planting. Two passes or "scans" of the study area were conducted each day, identifying individuals, recording migration patterns, noting utilized habitat types, and summarizing behavioral characteristics. If weather became inclement or water visibility was otherwise impaired, surveys were temporarily suspended. Following first observations of spawning-related behavior (approximately 1 September), activity monitoring intensified. During the peak spawn period (approximately 20 September), survey personnel recorded general health and condition of the fish, mate pairing, nest digging, and spawning behavior. Attempts at redd construction were classified as test digs or completed redds. Areas of excavation were flagged upon initial observation and monitored closely for progress and/or completion. Gravel size was noted as well as the number of nests completed. Interactions between bull trout and chinook salmon were also recorded. Fidelity to redd sites were recorded for females as well as the degree of wandering observed among males. When carcasses were recovered, locations were noted. In addition, carcasses were measured for fork length, inspected for milt or egg retention, scanned for PIT tags, and associated with external tag identification numbers. Surveys were terminated on Bear Valley Creek on 12 October.

Following the release of pre-spawn adult chinook salmon to the East Fork Salmon River, on 25 August, telemetry investigations were conducted on an every other day basis. The frequency of tracking increased to daily following first observations of spawning-related behavior. When radio-tagged fish were located, their positions were recorded on global positioning system (GPS) receivers (Lowrance GPS model GlobalNav 212). If observers were able to make visual contact with radio-tagged fish, behavioral observations (as described above for Bear Valley Creek) were recorded. Telemetry investigations were terminated on 24 September.

Production Monitoring

In July 1999, brood year 1998 production was monitored using standardized IDFG snorkeling techniques. Two groups of snorkelers surveyed Bear Valley Creek to assess fry production from captive adult chinook salmon planted in 1998. Each group consisted of two snorkelers, and one data recorder. Snorkel crews surveyed the entire study area on Bear Valley Creek from the blocking weir location upstream to the natural barrier at the upper end of the section. Following similar procedures, biologists from the Shoshone-Bannock Tribes conducted snorkel investigations on the West Fork Yankee Fork Salmon and East Fork Salmon rivers to assess production from 1998 outplants.

Spawning and Gamete Evaluations

Maturing adults from the West Fork Yankee Salmon and East Fork Salmon river stocks were retained as a precautionary measure to offset risk of cohort loss associated with low wild/natural adult escapement and low numbers of captive adults available to outplant. In the hatchery, we investigated several spawning variables, including gamete quality, fecundity, and egg survival to the eyed stage of development. Where possible, comparisons were made between seawater and freshwater rearing treatments.

Spawning followed accepted, standard practices as described by McDaniel et al. (1994) and Erdahl (1994). Guidance in developing spawn crosses was also received from University of Idaho geneticists. In general, eggs produced at spawning were divided into sublots (by female) and fertilized with fresh or cryopreserved milt from unique males (factorial design). Milt was preharvested and examined for motility prior to use. Eggs were incubated by sublot to yield lineage-specific groups. Overall egg quality was judged by examining egg size, clarity of ovarian fluid, and presence/absence of polarized or overripe eggs. Fecundities were developed by applying subsample weights (number of eggs per gram) to total egg weight for each female. Egg survival to the eyed stage was determined by subtracting dead or unfertilized eggs from the total estimated number of eggs for each female.

Cryopreservation

Cryopreservation of milt from male donors has been used in the captive rearing program since 1997 and follows techniques described by Cloud et al. (1990), and Wheeler and Thorgaard (1991). Milt is cryopreserved and stored at three locations (Eagle Fish Hatchery, University of Idaho, and Washington State University) to spread the risk associated with freezing technique error and storage system failure. In 1999, milt from brood year 1996 and 1997 West Fork Yankee Fork Salmon River chinook salmon was cryopreserved.

Hatch Box Program

Eyed-eggs produced from spawning activities at Eagle Fish Hatchery may be transferred to instream or streamside incubation boxes in cooperation with the Shoshone-Bannock Tribes. Instream incubation consists of Jordan-Scotty boxes anchored to the channel bottom at locations with suitable water depth, velocity, and substrate conditions. Streamside incubation systems consist of Whitlock-Vibert hatch boxes placed in larger incubation environments (modified refrigerators) plumbed with flow-through spring water.

In 1999, eyed-eggs produced from West Fork Yankee Fork Salmon River spawn crosses were transferred on 13 October to instream Jordan-Scotty boxes and streamside incubation systems located approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. Eyed-eggs produced from East Fork Salmon River spawn crosses were transferred on 2 November to instream Jordan-Scotty boxes located approximately 31 km upstream of the confluence of the East Fork and mainstem Salmon rivers.

Fish Health

During this reporting period, the Eagle Fish Health Laboratory processed 82 cases involving 125 individual chinook salmon. Routine fish necropsies included investigations for viral, bacterial, and parasitic disease agents. The majority of samples analyzed in 1999

originated from groups reared at Eagle Fish Hatchery. However, mortalities received from the Sawtooth Fish Hatchery shortly after field collection and adult chinook salmon transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory (WA) were also necropsied at the Eagle Laboratory. Juvenile chinook salmon destined for transfer to the Manchester Marine Laboratory for seawater rearing were vaccinated for *Vibrio* spp. Chinook salmon held at Eagle Fish Hatchery received periodic Aquamycin treatments (or prophylaxis) using medicated feeds. In addition, Erythromycin was also delivered to specific stocks through intraperitoneal injection. Manual inspection and removal of the gill parasite *Salmincola californiensis* continued in 1999 for all Lemhi River cohorts in culture at the Eagle Fish Hatchery. To control infestations, the use of the parasiticide Ivermectin continued in 1999.

RESULTS

Collections for Captive Rearing

Brood Year 1998

Lemhi River—In October of 1999, 191 age-0 chinook salmon parr were collected from the Lemhi River and transferred to the Sawtooth Fish Hatchery for temporary rearing.

West Fork Yankee Fork Salmon River—In July of 1999, 229 age-0 chinook salmon parr were collected from the West Fork Yankee Fork Salmon River and transferred to the Sawtooth Fish Hatchery for temporary rearing.

East Fork Salmon River—In August of 1999, 85 age-0 chinook salmon parr were collected from the East Fork Salmon River and transferred to the Sawtooth Fish Hatchery for temporary rearing. In October of 1999, an additional 100 age-0 parr were collected from the same system and transferred to Sawtooth Fish Hatchery for temporary rearing.

Brood Year 1999

Lemhi River—On 22 September 1999, three redds (Nos. 1, 7, 12) were hydraulically-sampled for eyed-eggs in the Lemhi River. Initial observations of completed redds occurred on 25 and 29 August 1999, and all redds were sampled after the accumulation of 290 Celsius temperature units (CTUs) of development. A total of 168 eyed-eggs were collected from redds 1, 7 and 12.

On 19 October 1999, four additional redds (Nos. 20, 21, 24, 25) were hydraulically-sampled for eyed-eggs in the Lemhi River. Initial observation of completed redds occurred on 8 September 1999, and all redds were sampled after the accumulation of 300 CTUs of development. Sampling conducted on 19 October yielded a total of 96 eyed-eggs.

Collections made in the Lemhi River in 1999 yielded a total of 264 eyed-eggs. All eggs were transferred to the Eagle Fish Hatchery for final incubation and rearing.

West Fork Yankee Fork Salmon River—No brood year 1999 eyed-eggs were collected from the West Fork Yankee Fork Salmon River as a result of low adult spawner escapement in 1999.

East Fork Salmon River—On 23 September 1999, one redd (No. 2) was hydraulically-sampled for eyed-eggs in the East Fork Salmon River. Initial observation of completed redd occurred on 25 August 1999, and sampling was conducted after the accumulation of 290 CTUs of development. In 1999, a total of 143 eyed-eggs were collected in the East Fork Salmon River and transferred to the Eagle Fish Hatchery for final incubation and rearing.

Fish Culture

The following information reflects culture history for the reporting period 1 January 1999 through 31 December 1999. During this reporting period, 16 rearing groups were in culture at IDFG facilities. Summaries of losses, transfers, and releases while in culture are presented in Tables 1, 2, and 3. In addition to the stock description (Lemhi River, West Fork Yankee Fork Salmon River, or East Fork Salmon River) of specific culture groups within a given brood year, captive chinook groups are further defined by collection origin through the use of an “NP,” “NE,” or “SN” nomenclature system. The acronym “NP,” or natural parr, denotes a naturally-produced culture group collected at the parr life-history stage and taken into captivity. The acronym “NE,” or natural egg, denotes a naturally-produced culture group collected at the egg life-history stage and taken into captivity. The acronym “SN,” or safety-net, denotes a hatchery-produced culture group resulting from hatchery crosses of naturally-produced parents.

BROOD YEAR 1994

At the beginning of the reporting period, seven Lemhi River-NP, two West Fork Yankee Fork Salmon River-NP, and 12 East Fork Salmon River-NP brood year 1994 chinook salmon were on station at Eagle Fish Hatchery (Tables 1, 2, and 3). On 8 July 1999, maturing Lemhi River-NP (N = 4), West Fork Yankee Fork Salmon River-NP (N = 3), and East Fork Salmon River-NP (N = 8) brood year 1994 adults were transferred from the Manchester Marine Laboratory to Eagle Fish Hatchery to complete maturation in fresh water. In August of 1999, nine Lemhi River-NP and seven East Fork Salmon River-NP maturing adults were released to Bear Valley Creek (Lemhi River system) and East Fork Salmon River, respectively, for natural spawning. Three West Fork Yankee Fork Salmon River-NP and five East Fork Salmon River-NP adults (not released to spawn) were retained for hatchery spawn crosses and resultant gamete evaluations. At the end of the reporting period, one East Fork Salmon River-NP captive chinook adult remained in culture at the Eagle facility. Maturation is expected from this single adult in 2000. There were no captive adults remaining in culture at Eagle from Lemhi River-NP and West Fork Yankee Fork Salmon River-NP stocks at the end of the reporting period.

Brood Year 1995

Thirty-six brood year 1995 Lemhi River-NP chinook salmon were on station at Eagle Fish Hatchery at the beginning of the reporting period (Table 1). No West Fork Yankee Fork Salmon River-NP or East Fork Salmon River-NP brood year 1995 chinook salmon were collected. In 1999, 25 brood year 1995 Lemhi River-NP adults were lost to bacterial kidney disease *Renibacterium salmoninarum*. Twenty-one maturing adults were transferred to Eagle

Fish Hatchery from the Manchester Marine Laboratory on 8 July 1999 to complete maturation in fresh water. On 24 August 1999, 25 maturing adults were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. No adults were retained at the Eagle facility for hatchery spawn crosses. At the end of the reporting period, one fish remained in culture at the Eagle Fish Hatchery. Maturation is expected in 2000.

Table 1. Summary of losses and magnitude of mortality for six Lemhi River (LR) captive chinook salmon culture groups reared at IDFG facilities in 1999.

	Culture Groups					
	BY94-NP	BY95-NP	BY96-NP	BY97-NP	BY98-NP	BY99-NE
Starting Inventory (January 1, 1999)	7	36	41	135	191 ^a	264 ^a
<u>Eyed-Egg to Fry</u> Undetermined ^b	n/a	n/a	n/a	n/a	n/a	20
<u>Mechanical Loss</u>						
Handling	0	0	1	1	1	0
Jump-out	0	0	0	7	0	0
<u>Non-infectious</u>						
Other ^c	1	6	2	0	1	0
<u>Infectious</u>						
Bacterial	1	25	1	0	1	0
Viral	0	0	0	0	0	0
Other	0	0	0	0	0	0
<u>Hatchery Spawning</u>						
Mature Males	0	0	0	0	0	0
Mature Females	0	0	0	0	0	0
Non-Viable	0	0	0	0	0	0
<u>Relocation</u>						
Transferred In	4	21	12	11	0	0
Transferred Out	0	0	0	102	0	0
Planted/Released	9	25	16	12	0	0
Ending Inventory (December 31, 1999)	0	1	33	24	188	244

^a Fall 1999 inventory.

^b Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.

^c Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

Table 2. Summary of losses and magnitude of mortality for five West Fork of the Yankee Fork of the Salmon River (WFYF) captive chinook salmon culture groups reared at IDFG facilities in 1999.

	Culture Groups				
	BY94-NP	BY96-NP	BY97-NP	BY98-NP	BY99-SN
Starting Inventory (January 1, 1999)	2	26	200	229 ^a	300 ^a
<u>Eyed-Egg to Fry</u> Undetermined ^b	n/a	n/a	n/a	n/a	21
<u>Mechanical Loss</u>					
Handling	0	12	0	3	0
Jump-out	0	0	8	0	0
<u>Non-infectious</u> Other ^c	1	2	1	7	0
<u>Infectious</u>					
Bacterial	1	3	1	0	
Viral	0	0	0	0	0
Other	0	0	0	0	0
<u>Hatchery Spawning</u>					
Mature Males	0	3	20	0	0
Mature Females	2	0	0	0	0
Non-Viable	1	0	0	0	0
<u>Relocation</u>					
Transferred In	3	0	18	0	0
Transferred Out	0	0	165	0	0
Planted/Released	0	0	0	0	0
Ending Inventory (December 31, 1999)	0	6	23	219	279

^a Fall 1999 inventory.

^b Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.

^c Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

Table 3. Summary of losses and magnitude of mortality for five East Fork of the Salmon River (EFSR) captive chinook salmon culture groups reared at IDFG facilities in 1999.

	Culture Groups				
	BY94-NP	BY98-NP	BY98-SN	BY99-NE	BY99-SN
Starting Inventory (January 1, 1999)	12	185	261	143 ^a	91 ^a
<u>Eyed-Egg to Fry</u> Undetermined ^b	n/a	n/a	n/a	2	4
<u>Mechanical Loss</u>					
Handling	0	0	0	0	
Jump-out	0	3	0	0	0
<u>Non-infectious</u> Other ^c	4	5	5	0	0
<u>Infectious</u>					
Bacterial	3	1	0	0	0
Viral	0	0	0	0	0
Other	0	0	0	0	0
<u>Hatchery Spawning</u>					
Mature Males	0	0	0	0	0
Mature Females	2	0	0	0	0
Non-Viable	3	0	0	0	0
<u>Relocation</u>					
Transferred In	8	0	0	0	0
Transferred Out	0	0	0	0	0
Planted/Released	7	0	0	0	0
Ending Inventory (December 31, 1999)	1	176	256	141	87

^a Fall 1999 inventory.

^b Typical egg to fry mortality includes non-hatching eggs, abnormal fry, and swim-up loss.

^c Includes culling associated with cultural anomalies, and all undetermined, non-infectious mortality.

Brood Year 1996

At the beginning of the reporting period, 41 Lemhi River-NP and 26 West Fork Yankee Fork Salmon River-NP brood year 1996 chinook salmon were in culture at the Eagle Fish Hatchery. Transferred to seawater rearing as smolts in 1998, no brood year 1996 East Fork Salmon River-NP captives were in culture at IDFG facilities in 1999. Twelve maturing Lemhi River-NP males were transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory on 8 July 1999 to complete maturation in fresh water. On 24 August 1999, all maturing Lemhi River-NP males ($N = 16$) were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. Three maturing West Fork Yankee Fork Salmon River-NP males were retained for hatchery spawn crosses, gamete evaluations and milt cryopreservation. No releases of maturing West Fork Yankee Fork Salmon River-NP males were conducted in 1999.

On 22 July 1999, 12 BY96 West Fork Yankee Fork Salmon River-NP captives, collected in the spring of 1998, died at the Eagle Fish Hatchery as a result of a water-inflow obstruction to the rearing tank. Circumstances of mortality for brood year 1996 chinook salmon are presented in Tables 1 and 2. At the end of the reporting period, 33 Lemhi River-NP and six West Fork Yankee Fork Salmon River-NP brood year 1996 captives remained in culture at the Eagle Fish Hatchery.

Brood Year 1997

At the beginning of the reporting period, 135 Lemhi River-NP and 200 West Fork Yankee Fork Salmon River-NP brood year 1997 chinook salmon, collected in the fall of 1998, were in culture at the Eagle Fish Hatchery. Collections of brood year 1997 East Fork Salmon River-NP chinook were not conducted due to low adult spawner escapement in 1997. On 13 May 1999, 102 Lemhi River-NP and 165 West Fork Yankee Fork Salmon River-NP were transferred, at smoltification, to the Manchester Marine Laboratory to complete rearing in seawater. Eleven Lemhi River-NP and 18 West Fork Yankee Fork Salmon River-NP brood year 1997 precocial males were transferred to Eagle Fish Hatchery from the Manchester Marine Laboratory on 6 August 1999 to complete maturation in fresh water. On 24 August 1999, all maturing Lemhi River-NP males ($N = 12$) were released to Bear Valley Creek (Lemhi River system) for natural spawning and evaluation. Twenty maturing West Fork Yankee Fork Salmon River-NP males were retained for hatchery spawn crosses, gamete evaluations and milt cryopreservation. No releases of maturing West Fork Yankee Fork Salmon River-NP males were conducted in 1999. At the end of the reporting period, 24 Lemhi River-NP and 23 West Fork Yankee Fork Salmon River-NP fish remained in culture at Eagle Fish Hatchery.

Brood Year 1998

In July through October of 1999, 191 Lemhi River-NP, 229 West Fork Yankee Fork Salmon River-NP, and 185 East Fork Salmon River-NP brood year 1998 chinook salmon were collected and transferred to the Sawtooth Fish Hatchery. In August and October of 1999, brood year 1998 collection groups were transferred from the Sawtooth Fish Hatchery to the Eagle Fish Hatchery for continued culture and evaluation. At the end of the reporting period, 188 Lemhi River-NP, 219 West Fork Yankee Fork Salmon River-NP, and 176 East Fork Salmon River-NP fish remained on station at the Eagle Fish Hatchery (Tables 1, 2 and 3).

A combination of low adult spawner escapement into the East Fork Salmon River and low number of maturing captive adult spawners at the Eagle Fish Hatchery in 1998 prompted members of the Chinook Salmon Captive Propagation Technical Oversight Committee (CSCPTOC) to advocate the initiation of a brood year 1998 East Fork Salmon River "safety-net" (SN) culture group. Eggs collected from maturing captive adult spawners in the hatchery would be retained to assure the availability of future brood years in the absence of natural production (i.e., low adult spawner escapement to a given drainage). Approximately 300 eyed-eggs from 1998 East Fork Salmon River spawn crosses were retained at Eagle Fish Hatchery for the establishment of a captive rearing safety net. The selection of eggs was based on nuclear and mitochondrial DNA data generated to guide 1998 spawn crosses. At the beginning of the reporting period, 261 brood year 1998 East Fork Salmon River-SN sac fry were on station at Eagle Fish Hatchery. Ending balance for the 1999 reporting period was 256 fish (Table 3).

Transfers of brood year 1998 captive groups to seawater rearing at the NMFS Manchester Marine Laboratory in Washington State are planned for May 2000.

Brood Year 1999

Chinook Salmon Captive Propagation Technical Oversight Committee concerns of disease history, parasite infestations, skewed sex ratios, and poor feed conversions of past natural parr (NP) collection groups prompted CSCPTOC members in 1999 to initiate the collection of fertilized chinook eggs at the "eyed" stage of development. A method now used more frequently in collection of captive salmonids throughout the Northwest, hydraulic-sampling of eggs in 1999 yielded a total of 264 and 143 eyed-eggs from the Lemhi River and East Fork Salmon River, respectively. No brood year 1999 eggs were collected from the West Fork Yankee Fork Salmon River in 1999 as a result of low (less than five) adult spawner escapement. At the end of the reporting period, 244 Lemhi River-NE and 141 East Fork Salmon River-NE sac fry were on station at the Eagle Fish Hatchery (Tables 1 and 3).

Approximately 300 West Fork Yankee Fork Salmon River-SN and 91 East Fork Salmon River-SN eyed-eggs from 1999 spawn crosses were retained at Eagle Fish Hatchery and not distributed to streamside or instream incubation systems. The selection of eggs was based on nuclear and mitochondrial DNA data generated to guide 1999 spawn crosses. All maturing Lemhi River adults were released in 1999, and a brood year 1999 Lemhi River-SN group was not established. At the end of the reporting period, 279 West Fork Yankee Fork Salmon River-SN and 87 East Fork Salmon River-SN sac fry were on station at Eagle Fish Hatchery (Tables 2 and 3).

FISH TRANSFERS

On 13 May 1999, 102 Lemhi River-NP and 165 West Fork Yankee Fork Salmon River NP brood year 1997 yearling smolts were transferred from Eagle Fish Hatchery to the Manchester Marine Laboratory for seawater rearing. Mean fish weight at transfer for brood year 1997 Lemhi River-NP and West Fork Yankee Fork Salmon River-NP groups was 52.79 g and 45.85 g, respectively. No collections of brood year 1997 East Fork Salmon River-NP occurred in 1998.

On 8 July 1999, maturing brood year 1994 Lemhi River-NP (N = 4), West Fork Yankee Fork Salmon River-NP (N = 3), and East Fork Salmon River-NP (N = 8) chinook salmon were transferred from the Manchester Marine Laboratory to Eagle Fish Hatchery to complete maturation in freshwater. Twenty-one brood year 1995 and 12 brood year 1996 maturing Lemhi River-NP chinook salmon were transferred on this same date. On 6 August 1999, an additional 11 Lemhi River-NP and 18 West Fork Yankee Fork Salmon River-NP brood year 1997 captive chinook salmon were transferred from the Manchester Marine Laboratory facility to Eagle Fish Hatchery.

Transfers of brood year 1998 NP captives (collected throughout the summer and fall of 1999) from Sawtooth Fish Hatchery to Eagle Fish Hatchery began on 4 August 1999 with the transfer of 229 West Fork Yankee Fork Salmon River-NP juveniles. Additional transfers occurred on 25 August (N = 85 East Fork Salmon River-NP juveniles) and 14 October 1999 (N = 191 Lemhi River-NP and 100 East Fork Salmon River-NP juveniles).

Monitoring Programs

Marking and Release

Bear Valley Creek—On 20 August 1999, nine brood year 1994, 25 brood year 1995, 16 brood year 1996, and 12 brood year 1997 Lemhi River-NP captive chinook salmon were marked at the Eagle Fish Hatchery for future release and monitoring. All fish were identified by brood year, rearing strategy (freshwater vs. seawater), PIT tag number, sex determination, and individual weight and fork-length data was recorded. Tag types included individually-numbered, variable-sized Petersen disc tags (white and yellow), and individually-numbered Floy tags (yellow). Specific tag-type was determined by the brood year, sex, and size of individual fish. A summary of marking activities detailing brood year, rearing strategy, PIT tag number, sex determination, individual weight and fork-length data, as well as tag type, number, and color of all marked fish is included in Table 4.

On 24 August 1999, the above-mentioned groups/numbers were transported to the Bear Valley Creek observation site and released. Field observation and monitoring occurred immediately after release and is discussed in the Spawning Behavior Monitoring Results section of this document.

Table 4. Summary of Lemhi River captive chinook salmon releases to Bear Valley Creek on 24 August 1999.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color
1994	Lemhi R.	Seawater	204B114B39	F	2000	55	Petersen	012	White
1994	Lemhi R.	Seawater	204C481834	F	2100	55	Petersen	020	White
1994	Lemhi R.	Seawater	204C386C70	F	1450	52	Petersen	038	White
1994	Lemhi R.	Seawater	204B2C3831	F	2650	60	Petersen	043	White
1994	Lemhi R.	Freshwater	7F7A0F2729	F	2700	56	Petersen	000	White
1994	Lemhi R.	Freshwater	200E181F1B	F	1250	47	Petersen	013	White
1994	Lemhi R.	Freshwater	1F7C0C0E4B	F	1500	49	Petersen	039	White
1994	Lemhi R.	Freshwater	1F7E400122	F	1450	48	Petersen	046	White
1994	Lemhi R.	Freshwater	204C474706	F	1950	53	Petersen	084	White
1995	Lemhi R.	Seawater	2036332453	F	2050	53	Petersen	003	White
1995	Lemhi R.	Seawater	2010423658	F	1250	47	Petersen	006	White
1995	Lemhi R.	Seawater	416D74043C	F	1500	50	Petersen	011	White
1995	Lemhi R.	Seawater	416C34305E	F	740	39	Petersen	015	White
1995	Lemhi R.	Seawater	200F6D1153	F	1500	49	Petersen	022	White
1995	Lemhi R.	Seawater	4165290640	F	1450	49	Petersen	029	White
1995	Lemhi R.	Seawater	200B202312	F	1500	51	Petersen	034	White
1995	Lemhi R.	Seawater	200F661952	F	2550	57	Petersen	041	White
1995	Lemhi R.	Seawater	416B7D1955	F	3200	61	Petersen	044	White
1995	Lemhi R.	Seawater	222E283671	F	3150	60	Petersen	047	White
1995	Lemhi R.	Seawater	200C256F40	F	1850	50	Petersen	050	White
1995	Lemhi R.	Seawater	1F7A561A77	F	2300	54	Petersen	051	White
1995	Lemhi R.	Seawater	416B641B4E	F	2000	53	Petersen	054	White
1995	Lemhi R.	Seawater	2010497512	F	2400	56	Petersen	071	White
1995	Lemhi R.	Seawater	203643481F	F	1600	49	Petersen	073	White
1995	Lemhi R.	Seawater	41706D213D	F	2050	54	Petersen	076	White
1995	Lemhi R.	Seawater	4170732F05	F	1350	47	Petersen	077	White
1995	Lemhi R.	Seawater	2010410807	F	2050	53	Petersen	078	White
1995	Lemhi R.	Seawater	416C174610	F	1700	50	Petersen	088	White
1995	Lemhi R.	Seawater	416C1F5134	F	2250	55	Petersen	089	White
1995	Lemhi R.	Freshwater	416D537D35	F	928	42	Petersen	002	White
1995	Lemhi R.	Freshwater	1F7A636024	F	1180	46	Petersen	010	White
1995	Lemhi R.	Freshwater	200F515729	F	1150	45	Petersen	017	White
1995	Lemhi R.	Freshwater	200E4F0E75	F	1250	45	Petersen	074	White
1995	Lemhi R.	Freshwater	201034425A	M	600	37	Petersen	016	Yellow

Table 4 Continued. Summary of Lemhi River captive chinook salmon releases to Bear Valley Creek on 24 August 1999.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color
1996	Lemhi R.	Seawater	416C60305F	M	793	38	Petersen	021	White
1996	Lemhi R.	Seawater	22316A0922	M	548	35	Petersen	000	Yellow
1996	Lemhi R.	Seawater	2231680E48	M	647	37	Petersen	002	Yellow
1996	Lemhi R.	Seawater	222E303250	M	569	35	Petersen	007	Yellow
1996	Lemhi R.	Seawater	222E206D70	M	582	35	Petersen	011	Yellow
1996	Lemhi R.	Seawater	222E26213E	M	744	39	Petersen	012	Yellow
1996	Lemhi R.	Seawater	416C597713	M	626	36	Petersen	014	Yellow
1996	Lemhi R.	Seawater	4170602817	M	495	34	Petersen	018	Yellow
1996	Lemhi R.	Seawater	222E21255B	M	660	37	Petersen	022	Yellow
1996	Lemhi R.	Seawater	222E46290E	M	562	35	Petersen	025	Yellow
1996	Lemhi R.	Seawater	1F7B770867	M	894	41	Petersen	028	Yellow
1996	Lemhi R.	Freshwater	22316D3E2D	M	564	34	Petersen	001	Yellow
1996	Lemhi R.	Freshwater	415A183761	M	520	36	Petersen	017	Yellow
1996	Lemhi R.	Freshwater	222E237844	M	288	29	Petersen	019	Yellow
1996	Lemhi R.	Freshwater	2231653226	M	316	29	Petersen	020	Yellow
1996	Lemhi R.	Freshwater	2231547F4F	M	330	32	Petersen	026	Yellow
1997	Lemhi R.	Seawater	515F4F7917	M	121	21	Floy	004	Yellow
1997	Lemhi R.	Seawater	515B425141	M	114	20	Floy	005	Yellow
1997	Lemhi R.	Seawater	515C006E3E	M	97	19	Floy	006	Yellow
1997	Lemhi R.	Seawater	515F551C08	M	139	21	Floy	007	Yellow
1997	Lemhi R.	Seawater	515F566A51	M	153	22	Floy	008	Yellow
1997	Lemhi R.	Seawater	5160252217	M	82	19	Floy	009	Yellow
1997	Lemhi R.	Seawater	515C005726	M	183	24	Floy	010	Yellow
1997	Lemhi R.	Seawater	515B782603	M	132	21	Floy	011	Yellow
1997	Lemhi R.	Seawater	515D2E3D61	M	127	21	Floy	012	Yellow
1997	Lemhi R.	Seawater	515B480B04	M	124	20	Floy	013	Yellow
1997	Lemhi R.	Seawater	515B7B3103	M	64	17	Floy	014	Yellow
1997	Lemhi R.	Freshwater	51602C3858	M	176	22	Floy	003	Yellow

Table 5. Summary of East Fork Salmon River (EFSR) captive chinook salmon releases to the EFSR on 25 August 1999.

Brood Year	Stock	Rearing Origin	PIT Number	Sex	Weight (g)	Fk. Length (cm)	Tag Type	Tag Number	Tag Color	Radio Frequency
1994	EFSR	Seawater	2043473422	F	2650	60	Petersen	015	White	150.109
1994	EFSR	Seawater	204B2A0A61	F	2600	60	Petersen	017	White	151.533
1994	EFSR	Seawater	20433E322D	F	2250	55	Petersen	027	White	150.259
1994	EFSR	Seawater	20433E6E71	F	1500	53	Petersen	039	White	151.861
1994	EFSR	Seawater	20484C6567	F	3050	63	Petersen	042	White	150.131
1994	EFSR	Freshwater	204C4C6662	F	1650	52	Petersen	011	White	150.512
1994	EFSR	Freshwater	204E7E474D	M	1000	40	Petersen	018	White	151.842

East Fork Salmon River—On 20 August 1999, seven brood year 1994 East Fork Salmon River-NP captive chinook salmon (six females, one male) were marked at the Eagle Fish Hatchery for future release and monitoring. Five and one of the six females originated from seawater and freshwater, respectively, and the single male originated from freshwater rearing. All fish received individually-numbered Petersen disc tags and internal radio transmitters. A summary of marking activities detailing brood year, rearing strategy, PIT tag number, sex determination, individual weight, and fork-length data, as well as tag type, number, color, and radio-tag frequency of all marked fish is included in Table 5.

On 25 August 1999, the above-mentioned fish were transported to the East Fork of the Salmon River and released. Field observation and monitoring occurred immediately after release and is discussed in the Spawning Behavior Monitoring Results section of this document.

Spawning Behavior Monitoring

Bear Valley Creek—Captive-reared chinook salmon (29 males and 33 females) were outplanted into Bear Valley Creek on 24 August 1999. Behavioral observations commenced immediately and were conducted through 12 October. All captive-reared fish were marked with visible external tags (Petersen disc of Floy).

We recorded a total of 433 unique observations of outplanted chinook salmon. Observations were associated with 30 of the 33 female and seven of the 29 male salmon released to the study section. First signs of agonistic behavior were recorded shortly after release on 30 August. First signs of test digging were recorded on 31 August. Most redd construction activity was observed between 10 September and 30 September. A total of 31 suspected redds were identified during the survey period.

Over 30 direct observations of chinook salmon spawning were recorded. In some cases, chinook salmon redds were superimposed on bull trout redds or on other chinook salmon redds. Several chinook salmon females were observed moving from one area of excavation to another. Some females were observed working gravel at four different locations. There were approximately 11 observations made of bull trout and chinook salmon paired over the same redd. In many of these cases, we observed spawning-related behavior between bull trout and chinook salmon.

A total of six male and 11 female carcasses were recovered. Nine female carcasses were examined for egg retention. Five of the nine females (56%) appeared to have spawned and deposited the vast majority of their eggs. The mean number of retained eggs for these five females was 17.2 (range three to 30 eggs). One partially spawned female was recovered with 698 retained eggs and three females were recovered that appeared to have died prior to the commencement of spawning (mean retained eggs = 1,536, range = 1,175 to 1,933).

East Fork Salmon River—Captive-reared chinook salmon were outplanted into the East Fork Salmon River on 25 August, 1999. Adjacent to the release site, we observed several wild/natural chinook salmon spawning. There were seven captive-reared chinook salmon released adjacent to this natural spawning activity (one male and six females). All seven fish in this release group were radio-tagged and Petersen disk-tagged to facilitate tracking and the recording of spawning-related behavior.

On 15 September, we observed one of the six captive-reared females in close proximity to what appeared to be a completed redd. Her caudal fin was worn, but no male chinook salmon were observed in the vicinity. On 24 September, her carcass was recovered and only ten retained eggs were found in her body cavity. Five of the six captive-reared females were not observed participating in spawning-related activity or observed near suspected redds. Three transmitters from these five females were recovered during final telemetry surveys in September. Two of the three recovered transmitters were not associated with carcasses when found. The third transmitter was recovered from a carcass that had most eggs intact in the body cavity. This fish had a large body wound and may have been attacked by a predator prior to spawning. The single captive-reared male was observed on several occasions but never in close proximity to wild/natural or captive-reared females. The transmitter from this fish was recovered on 24 September.

Production Monitoring

Snorkel surveys were conducted in July 1999 in Bear Valley Creek, the East Fork Salmon River, and the West Fork Yankee Fork Salmon River to document presence/absence of young-of-the-year chinook salmon produced from 1998 adult outplants to these systems. Surveys were conducted near locations where captive adults were released or eggs were planted. No juvenile chinook salmon were observed during these surveys.

GAMETE EVALUATIONS

West Fork Yankee Fork Salmon River—Two brood year 1994 West Fork Yankee Fork Salmon River-NP females with seawater rearing history produced a total of 2,597 eyed-eggs in 1999. Three brood year 1996 West Fork Yankee Fork Salmon River-NP freshwater rearing treatment males and three brood year 1997 West Fork Yankee Fork Salmon River-NP seawater rearing treatment males were used in the spawning design. Mean fecundity for the brood year 1994 females averaged 1,644 eggs and mean egg survival to the eyed stage of development averaged 79.01% (Table 6). One additional brood year 1994 West Fork Yankee Fork Salmon River-NP female of the seawater rearing treatment was spawned yielding 1,172 eggs; however, all eggs were determined nonviable and later culled. No brood year 1994 West Fork Yankee Fork Salmon River-NP females of the freshwater rearing strategy were spawned in 1999. Four unique subfamilies were produced from 1999 spawn crosses. Mean fork length and weight for brood year 1994 female spawners averaged 536 mm and 1,572 g, respectively. Brood year 1996 males used in spawn crosses averaged 288 mm in fork-length and 270 g in weight. Mean fork length and weight for brood year 1997 male spawners averaged 193 mm and 84 g, respectively.

Table 6. Summary of 1999 spawning data for West Fork of the Yankee Fork of the Salmon River (WFYF) and East Fork of the Salmon River (EFSR) captive chinook salmon. Data for males reflects the use of fresh milt, except where noted. FW and SW reference freshwater and seawater rearing treatments.

Stock and Rearing History	Number of Unique Females Spawned	Number of Unique Males Spawned	Mean Female Fecundity	Mean Egg Survival to the Eyed Stage	Number of Eyed-Eggs Produced
WFYF-SW ^a	2	6	1,644	79.01%	2,597
EFSR-FW ^b	1	4 cryo ^c	391	10.49%	41
EFSR-SW ^b	1	4 cryo ^c	2,596	41.91%	1,088

^a All females from brood year 1994. Three and three of the six males from brood year 1996 and 1997, respectively.

^b All females from brood year 1994. All cryopreserved milt from brood year 1994 males cryopreserved as age-3 (2 males) and age-4 (2 males) fish.

^c Cryopreserved milt used in EFSR spawning matrix.

East Fork Salmon River—In 1999, a total of 1,129 eyed-eggs were produced from East Fork Salmon River-NP spawn crosses completed at Eagle Fish Hatchery. Two brood year 1994 females (one freshwater and one seawater rearing history fish) and cryopreserved milt from four males was used in the spawning design. Milt was obtained from brood year 1994 East Fork Salmon River-NP males cryopreserved in 1997 and 1998. We did not attempt to fertilize eggs produced from three captive females (two freshwater and one seawater history fish) based on observations of substantial egg deformation, egg retention, yolk polarization, and discolored ovarian fluid. Fecundity and egg survival to the eyed stage of development was 391 eggs and 10.49%, respectively, for the brood year 1994 freshwater rearing group female (Table 6). Fecundity and egg survival to the eyed stage of development for the seawater rearing group female was 2,596 and 41.91%, respectively (Table 6). The brood year 1994 freshwater rearing history female was 520 mm in fork length and 1,449 g in weight. Mean fork length and weight for the brood year 1994 seawater rearing history female was 625 mm and 2,528 g, respectively.

Cryopreservation

On 29 September 1999, milt from maturing brood year 1996 (N = 1) and brood year 1997 (N = 17) West Fork Yankee Fork Salmon River-NP captive chinook salmon was cryopreserved at Eagle Fish Hatchery. The single brood year 1996 male originated from the freshwater rearing strategy, and one and 16 of the brood year 1997 males originated from freshwater and seawater rearing strategies, respectively. Collection efforts in 1999 produced a total of 448, 0.5 ml straws. Details of this event are presented in Table 7. No milt cryopreservation was conducted on Lemhi River or East Fork Salmon River males in 1999. In addition, no program transfers of cryopreserved milt were conducted and no cryopreservation activities were performed at the University of Idaho or Washington State University in 1999.

Cryopreserved milt from brood year 1994 East Fork Salmon River-NP males was utilized in the 1999 spawning design for East Fork Salmon River-NP adults at Eagle Fish Hatchery.

Forty-seven, 0.5 ml straws from brood year 1994 East Fork Salmon River-NP males cryopreserved in 1997 (two males) and 1998 (two males) was used to fertilize a total of 2,987 green eggs. Spawn crosses utilizing cryopreserved milt yielded a total of 1,129 eyed-eggs, for a survival to the eyed-stage of development mean of 37.8%.

Table 7. Summary of 29 September 1999 milt cryopreservation activities at the Eagle Fish Hatchery. (BY = Brood Year, WFYF = West Fork of the Yankee Fork of the Salmon River).

Rearing Group	Number of Males Used	Number of 0.5 ml Straws Cryopreserved	Average Milt Motility	Motility Range
BY96 WFYF	1	24	98.0%	--
BY97 WFYF	17	424	98.1%	90.0% to 100.0%

Hatch Box Program

1998 Production—Eyed-eggs produced from 1998 spawning activities at Eagle Fish Hatchery were transferred to instream or streamside incubation boxes in cooperation with the Shoshone-Bannock Tribes. Instream incubation consisted of Jordan-Scotty boxes anchored to the channel bottom at locations with suitable water depth, velocity, and substrate conditions. Streamside incubation systems consisted of Whitlock-Vibert hatch boxes placed in larger incubation environments (modified refrigerators) plumbed with flow-through spring water. A total of 9,320 eyed-eggs produced from Lemhi River spawn crosses were planted in one streamside incubator located adjacent to Hayden Creek, a tributary to the Lemhi River. The incubation site was approximately 7 km upstream of the confluence of Hayden Creek and the Lemhi River. A total of 3,393 eyed-eggs produced from West Fork Yankee Fork Salmon River spawn crosses were planted in one streamside incubator located adjacent to the river approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. East Fork Salmon River eyed-eggs were planted in 15 instream Jordan-Scotty boxes (N = 15,240 total eyed) and one streamside incubator (N = 2,039 eyed) approximately 31 km upstream of the confluence of the East Fork and mainstem Salmon rivers.

Captive chinook program biologists from the Shoshone-Bannock Tribes monitored the survival and development of incubating eggs and fry throughout the winter of 1998-1999. Following emergence and emigration from the incubation site, incubation systems were examined and dead eggs/fry enumerated to determine an estimated hatching rate for individual locations. Estimated hatching rates were variable and ranged from a low of 62.29% for East Fork Salmon River streamside incubators to a high of 92.13% for West Fork Yankee Fork Salmon River streamside incubators. A summary of transfer locations, transfer dates, eyed-egg numbers and hatching rates is provided in Table 8.

Table 8. Summary of 1998 captive chinook salmon eyed-egg transfers and hatching rates for instream and streamside incubation boxes.

Location	Number of Eyed-Eggs Transferred	Dates Transferred	Number of Eyed-Eggs Planted	Estimated Hatching Rate
West Fork Yankee Fork	3,451 ^a	11/2/98	3,393	92.13%
Lemhi River Hayden Creek Site	9,324 ^b	11/2/98	9,320	75.00%
East Fork Salmon River	15,240 ^c	11/2/98, 11/7/98	15,240	91.04%
East Fork Salmon River Big Boulder Creek Site	2,039 ^d	11/2/98, 11/7/98	2,039	62.29%

^a All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork of the Yankee Fork of the Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.

^b All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 Lemhi River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.

^c All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork of the Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel incubators at fifteen locations.

^d All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork of the Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside location.

1999 Production—Eyed-eggs produced from 1999 spawning activities at Eagle Fish Hatchery were transferred to instream or streamside incubation boxes in cooperation with the Shoshone-Bannock Tribes. Instream incubation consisted of Jordan-Scotty boxes anchored to the channel bottom at locations with suitable water depth, velocity, and substrate conditions. Streamside incubation systems consisted of Whitlock-Vibert hatch boxes placed in larger incubation environments (modified refrigerators) plumbed with flow-through spring water. A total of 2,297 eyed-eggs produced from West Fork Yankee Fork Salmon River spawn crosses were planted in one streamside incubator located adjacent to the river (N = 1,468 eyed-eggs) and in one instream Jordan/Scotty box (N = 829 eyed-eggs), both located approximately 3 km upstream of the confluence with the mainstem Yankee Fork Salmon River. A total of 1,038 East Fork Salmon River eyed-eggs were planted in one instream Jordan-Scotty box approximately 31 km upstream of the confluence of the East Fork and mainstem Salmon rivers. No Lemhi River spawn crosses of captive maturing adults occurred in 1999. A summary of transfer locations, transfer dates, and number of eyed-eggs planted is provided in Table 9.

Post-transfer evaluation of incubation systems was conducted by the Shoshone-Bannock Tribes throughout the end of this reporting period. Due to continued hatching and development of eggs/embryos, results were not available at the time of this writing and will be summarized in 2000 reporting.

Table 9. Summary of 1999 captive chinook salmon eyed-egg transfers to instream and streamside incubation boxes.

Destination	Number of Eyed-Eggs Transferred	Dates Transferred
West Fork Yankee Fork	829 ^a	10/13/99
West Fork Yankee Fork	1,468 ^b	10/13/99
East Fork Salmon River	1,038 ^c	11/2/99

^a All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork of the Yankee Fork of the Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel incubators.

^b All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 West Fork of the Yankee Fork of the Salmon River captive chinook salmon. Eggs planted in Whitlock-Vibert boxes in one streamside incubation system.

^c All eyed-eggs produced at Eagle Fish Hatchery from brood year 1994 East Fork of the Salmon River captive chinook salmon. Eggs planted in Jordan/Scotty in-gravel incubators.

FISH HEALTH

In 1999, 82 laboratory accessions (representing 125 fish) were generated at the Eagle Fish Health Laboratory for captive chinook salmon. Cause of mortality and magnitude of loss for chinook salmon maintained at the Eagle Fish Hatchery during this reporting period are presented in Tables 1 through 3.

Principle fish health concerns included the presence of bacterial kidney disease *Renibacterium salmoninarum* (BKD), whirling disease *Myxobolus cerebralis* (WD), and the presence of the parasitic gill copepod *Salmincola californiensis*. In addition, maturing chinook salmon transferred to the State of Idaho from the NMFS Manchester Marine Laboratory in Washington State were screened for the North American strain of viral hemorrhagic septicemia (NA VHS) and *Piscirickettsia salmonis*. These pathogens do not occur in Idaho but have recently been identified in fish reared at a seawater net pen location in close proximity to the NMFS site. Because of the risk associated with the potential introduction of NA VHS, ovarian fluid and tissues sampled from NMFS-origin fish were "blind-passed" to improve our ability of detecting the virus. There was no evidence of virus demonstrated from routine procedures in addition to these extra procedures.

Monitoring for BKD in captive chinook salmon has been routinely conducted since the inception of the program in 1995. Of the 125 fish examined in 1999, 37 demonstrated clinical levels of this disease. The majority of mortality associated with BKD (25 cases) occurred in brood year 1995 chinook salmon from the Lemhi River. In addition to this loss, the following mortality was associated with BKD in 1999: 1) five (combined) brood year 1994 Lemhi, West Fork Yankee Fork Salmon, and East Fork Salmon river fish, 2) four (combined) brood year 1996 Lemhi and West Fork Yankee Fork Salmon river fish, 3) one brood year 1997 West Fork Yankee Fork Salmon River fish, and 4) two (combined) brood year 1998 Lemhi and East Fork

Salmon river fish. All BKD-related mortality was associated with rearing groups collected as natural parr or smolts. No BKD was identified in the one safety-net rearing group on station during this reporting period (brood year 1998 East Fork Salmon River safety net). As an additional precaution, brood year 1998 Lemhi, West Fork Yankee Fork Salmon, and East Fork Salmon river fish collected as natural parr were given two intraperitoneal injections with Erythromycin (ERY) within two months of collection. Periodic prophylactic treatments with ERY-medicated feed also occurred in 1999.

In 1999, Lemhi River chinook salmon juveniles infested with gill parasites were treated with the parasiticide Ivermectin. The treatment was administered by gastric intubation to all age-classes in culture. During Ivermectin treatments, gill parasites were also manually removed using forceps. Prior efforts to control the infestation by manual removal had not been effective. In addition, the handling associated with repeated attempts at manual removal, the degree of gill necrosis, and a generally poor feeding response most likely exacerbated BKD-related mortality observed in brood year 1995 Lemhi River chinook salmon described above. By the end of this reporting period, Ivermectin treatment had resulted in the elimination of the parasite in all age-classes. Current practice is to administer Ivermectin shortly after natural parr are collected and brought into the hatchery

Natural chinook juveniles collected from the Lemhi River (and to a lesser extent, the West Fork Yankee Fork Salmon River) are infected with *Myxobolus cerebralis*, the causative agent of salmonid whirling disease. For Lemhi River chinook salmon juveniles, the prevalence of infection has averaged approximately 38%. Mortality has not been attributed to the parasite, but occasional deformities have been observed.

LITERATURE CITED

- Bowles, E. 1993. Operation of compensation hatcheries within a conservation framework, an issue paper. Idaho Department of Fish and Game. Boise, Idaho.
- Bromage, N. R. and R. J. Roberts. 1995. Broodstock Management and Egg and Larval Quality. Blackwell Science Ltd. Cambridge, Massachusetts.
- Cloud, J. G., W. H. Miller, and M. J. Levenski. 1990. Cryopreservation of sperm as a means to store salmonid germ plasm and to transfer genes from wild fish to hatchery populations. *The Progressive Fish Culturist* 52:51-53.
- Erdahl, D. A. 1994. Inland Salmonid Broodstock Management Handbook. United States Department of the Interior, Fish and Wildlife Service. 712 FW 1.
- Flagg, T. A. and C. V. W. Mahnken. 1995. An assessment of the status of captive broodstock technology for Pacific Salmon. Final report to the Bonneville Power Administration, Project No. 93-56, Contract No. DE-A179-93BP55064. Portland, Oregon.
- Flemming, I. A. and M. R. Gross. 1992. Reproductive behavior of hatchery and wild coho salmon (*Oncorhynchus kisutch*): does it differ? *Aquaculture* 103:101-121.
- Flemming, I. A. and M. R. Gross. 1993. Breeding success of hatchery and wild coho salmon (*Oncorhynchus kisutch*) in competition. *Ecological Applications* 3(2):230-245.
- Hassemer, P. 1998. Upper Salmon River spring chinook salmon in Idaho. *In*: U.S. Fish and Wildlife Service. 1998. Proceedings of the Lower Snake River Compensation Plan Status Review Symposium. Compiled by USFWS-LSRCP. Boise, Idaho.
- Hassemer, P., P. Kline, J. Heindel, and K. Plaster. 1999. Captive rearing initiative for Salmon River chinook salmon. Project progress report to Bonneville Power Administration. Contract Numbers 97-BI-97583 and 98-BI-63416. Portland, Oregon.
- Idaho Department of Fish and Game. 1996. Fisheries Management Plan, 1996-2000. Idaho Department of Fish and Game. Boise, Idaho.
- Joyce, J. E., R. M. Martin, and F. P. Thrower. 1993. Successful maturation of captive chinook salmon broodstock. *Progressive Fish-Culturist*. 55:191-194.
- Leitritz, E. and R. C. Lewis. 1976. Trout and salmon culture (hatchery methods). California Department of Fish and Game Fish Bulletin 164.
- Marmorek, D., C. Peters, and I. Parnell, eds., and 32 contributors. 1998. PATH. Final Report for fiscal year 1998. ESSA Technologies Ltd., Vancouver, British Columbia, Canada.
- McDaniel, T. R., K. M. Prett, T. R. Meyers, T. D. Ellison, J. E. Follett, and J. A. Burke. 1994. Alaska Sockeye Salmon Culture Manual. Special Fisheries Report No. 6. Alaska Department of Fish and Game. Juneau, Alaska.

- McNeil, W. J. 1964. A method of measuring mortality of pink salmon eggs and larvae. United States Fish and Wildlife Service, Fisheries Bulletin. 63(3): 575-588.
- National Marine Fisheries Service (NMFS). 1995. Proposed Recovery Plan for Snake River Salmon. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. NMFS Protected Resources Division. Portland, Oregon.
- Northwest Power Planning Council (NPPC). 1994. Columbia River Basin Fish and Wildlife Program. Portland, Oregon.
- Pennell, W. and B. A. Barton. 1996. Principles of Salmonid Aquaculture. Elsevier Science B. V. Amsterdam, The Netherlands.
- Petrosky C. E. and H. A. Schaller. 1994. A comparison of productivities for Snake River and lower Columbia River spring and summer chinook salmon stocks. *In* Salmon Management in the 21st Century: Recovering Stocks in Decline. Proceedings of the 1992 Northeast Pacific Chinook and Coho Workshop. Idaho Chapter of the American Fisheries Society. Boise, Idaho.
- Piper, G. R., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Gowler, and J. R. Leonard. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service, Washington, D.C.
- Schaller, H. A., C. E. Petrosky, and O. P. Langness. 1999. Contrasting patterns of productivity and survival rates for stream-type chinook salmon (*Oncorhynchus tshawytscha*) populations of the Snake and Columbia rivers. Can. J. Fish. Aquat. Sci. 56:1,031-1,045.
- Schmitt, R., W. Stelle, and M. Brentwood. 1997. Draft Snake River Salmon Recovery Plan. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
- Wheeler, P. A. and G. A. Thorgaard. 1991. Cryopreservation of rainbow trout semen in large straws. Aquaculture 93:95-100.